Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, DC 20554

In the Matter of	)	
	)	
Promoting the Deployment of 5G Open Radio	)	GN Docket No. 21-63
Access Networks	)	

COMMENTS OF ERICSSON

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EXECUTIVE SUMMARY

As the Commission gathers more facts about the current state of open networking technologies, Ericsson submits that its focus, and the focus of the U.S. government, should be on ensuring a vibrant and competitive market for trusted vendors; not by insisting on any particular network standard, but by maintaining an open, predictable and attractive investment climate for all industry stakeholders and allowing operators to select the best technology based on their needs. This is the path for successful innovation and broad value creation.

Ericsson has consistently led the world in advancing the capabilities of wireless technology and devices and continues to do so during the global migration to 5G. The first live 5G network in the world was powered by Ericsson equipment. The world's first stand-alone 5G network was launched in the U.S. using Ericsson equipment. And Ericsson was the first company to deliver 5G base stations manufactured at scale in the U.S. Ericsson has over 7,700 employees in the U.S., operates R&D centers engaging in silicon design and artificial intelligence, among other things, in multiple American cities, and plans still more investment in Centers of Excellence and other facilities that will drive American 5G success. Approximately 90% of the value of our active Radio Access Network ("RAN") components come from U.S. companies. Ericsson was first to launch 5G with all Tier 1 operators and has five live 5G networks in the U.S. In all, the U.S. represents over 30% of Ericsson's global business volume.

Ericsson Supports Open Architectures. Ericsson heartily supports openness and the evolution to increasingly open network architectures. The benefits of Open RAN are evident in our own Cloud RAN portfolio, which focuses on hardware/software disaggregation, cloudification, open automation, and orchestration. Decoupling software and hardware allows RAN software to run on vendor-independent hardware, increasing vendor diversity. Increasing intelligence and automation allows operators to use tools to automate and simplify network operations on these decoupled, independent cloud platforms.

In addition, Ericsson is also a leader in the O-RAN Alliance. Ericsson co-chairs two working groups, made more contributions to O-RAN specifications in 2020 than any other company, and has the second-highest number of open source commitments and unique authors. Ericsson is currently supporting, or plans to support, eight of the ten RAN interfaces under discussion by the Alliance.

Ericsson undertook its Cloud RAN initiative when it did because the time was right from a *technology* and *business* perspective. We urge the Commission to recognize the openness evident in the marketplace today, and to foreswear use of government mandates to drive the marketplace toward any particular vision of openness.

Instead of mandating or expressing a preference for a particular architecture, allow the industry to adopt the architecture based on the technology and business risks, without forcing the market to make any investment decisions that could create significant deployment risk for U.S operators.

What is Open RAN? In order to consider policy responses to Open RAN, the Commission must understand what Open RAN is, including the roles played by the Third Generation Partnership Project ("3GPP") and the O-RAN Alliance. Open RAN is not a standard, but rather an industrial concept. It builds on the collection of standards currently developed through both 3GPP and technical specifications developed by the O-RAN Alliance. These standards and technical specifications are used to create more open internal RAN interfaces with the aim of helping to integrate new vendors into the supply chain.

The term "Open RAN" refers to three related developments: "cloudification" of wireless networks whereby the software and hardware components are disaggregated, allowing RAN software to run on vendor-independent hardware; the increased use of intelligence and automation, using artificial intelligence and machine learning to automate network operations; and the use of open internal RAN interfaces to facilitate interoperability.

Open RAN is built on top of standards produced by 3GPP, a contributions-based standards group representing over 700 companies. Ericsson is a leading contributor to 3GPP's standards-setting bodies. 3GPP is an open, consensus-based organization that has facilitated each generation of mobile technology from 3G to 5G and its governance procedure is compliant with the World Trade Organization's Technical Barriers to Trade agreement. 3GPP is the only global open standard that specifies all necessary technical domains that are required to build an interoperable mobile system and the devices attached to it. 3GPP also ensures backward compatibility between all the Gs—from 2G to 5G which is essential for rural areas were technology transitions are ongoing.

3GPP is committed to enabling vendor diversity. For example, 3GPP enables different vendor ecosystems for devices, radio access networks and core networks. Any company may join and develop its own set of products based on 3GPP specifications. 3GPP has enabled the success of the global mobile communications industry, with over 8 billion mobile subscriptions in use today.

The O-RAN Alliance, in turn, is a relatively new organization that took work from 3GPP's standards organizations as its baseline and set out to create extensions specifically for the RAN domain and for 4G and 5G only, not for 2G and 3G. Founded in 2018 by AT&T, China Mobile and others, the O-RAN Alliance comprises 28 operators and 224 vendor companies as of March 4, 2021. This body is defining specifications for a version of Open RAN called "O-RAN." The O-RAN Alliance's goal is to provide detailed blueprints for how to build a RAN solution enabling the integration of parts from different vendors, including defining mechanisms for efficient management and control.

An open, transparent, balanced, and voluntary consensus-based standards development process (such as the process used at 3GPP and its regional partners) creates a dynamic and competitive marketplace enabling the development of the best technology. FRAND licensing (licensing on Fair, Reasonable and, Non-Discriminatory terms) is a critical aspect of the continued innovation and competitiveness in 5G. Strong intellectual property protections, including respect for patent rights, are key to maintaining U.S. technological leadership, security, and a competitive innovation ecosystem in 5G, 6G and beyond.

Opportunities for Open RAN to Mature. The Commission is not "choosing" between Open RAN and 5G. 5G has been, and will continue to, evolve and all vendors will gradually phase in and introduce new nodes, software, and tools that will drive increasingly open, and software-defined, architectures.

Examples of Open RAN, including Ericsson's own Cloud RAN, are in the early stages of commercialization, with limited deployments at scale, compared to the 138 integrated 5G networks globally. While Open RAN has the potential to benefit the industry, its specifications are still evolving, which means that today there are several challenges related to successful adoption.

Atop any list is network security given the expanded threat surface associated with Open RAN's multivendor approach. Energy performance is another aspect for Open RAN to address. Energy efficiency has improved 10-30% per year in mobile networks. In addition, Ericsson estimates that, when considering the full network, Open RAN networks require approximately 40% higher power consumption than integrated networks.

Open RAN can also address spectrum efficiency. Ericsson's radios are designed with efficiency in mind—some advanced Ericsson gear can increase the application coverage by up to 10 dB over O-RAN systems. This translates into more efficient use of the radio spectrum resource, resulting in fewer sites to cover a given geographic area or superior coverage and capacity with same number of sites.

Other areas to consider include the need for systems integrators to consistently ensure that evolving hardware and software components reliably work together; the need for aggressive performance management to ensure that each piece of the network is operating effectively; protection of RAN vendors' intellectual property rights; the need to complete Open RAN-related standards; concerns regarding continued support for legacy 2G and 3G networks; and whether Open RAN savings on individual components are offset by increased system integration costs.

Next Steps for the Commission. The U.S. has the most innovative and competitive high-tech marketplace in the world, and a major key to that success is the fact that the *market* determines which technologies win, and which lose. Governments tipping the scales in the technology arena generally do not generate desired outcomes, and it would be a gamble to push innovators onto any particular technological path—especially in an area in which technical specifications are still being developed. Ericsson thus asks that the Commission continue its approach of leveraging market forces and technical advances to drive network architecture, and not impose requirements or firm preferences designed to push the market toward Open RAN.

Ericsson has five specific recommendations as the Commission works to promote the transition toward open wireless networks:

- **Remain Stalwart in Advancing 5G:** 5G's benefits are beyond dispute. American success in 5G can and should involve trusted vendors from around the globe. U.S. 5G

success requires rapid buildout of the 5G infrastructure to establish the platform for innovation. Much of U.S. innovation and economic success is underpinned by this infrastructure. The Commission should focus on continuing its work to accelerate current 5G deployments to maximize gains and the economic benefits.

- **Maintain Technological Neutrality:** The Commission should support a technology neutral environment that promotes innovation, in which the best price/performance ratio carries the day. This was the path toward U.S. leadership in the past, and nations that departed from this course have come to regret doing so (*e.g.* Chinese experience with TD-SCDMA).

- **Promote Test Beds:** Ericsson has launched an Open Lab to further development of new solutions and urges the Commission and its partners to promote the creation of similar test beds. The Commission could, for example, work with the Department of Defense to manage a multi-vendor "Open Ecosystem Plugfest" allowing vendors to contribute and test components throughout the 5G stack, as well as perform ecosystem application testing.

- **Support U.S. Participation in Standards Groups**: Ericsson recommends that the U.S. Government support industry engagement in global Standards Development Organizations (e.g. 3GPP, Institute of Electrical and Electronics Engineers ("IEEE")), and others to ensure that industry-led forums remain the principle organizations for standards development.

- **Do Not Delay Rip-and-Replace:** Operators involved in the "Rip and Replace" process should not receive special treatment as a result of choosing to deploy a particular solution. Congress was clear that the Replacement List was to be technology neutral. Moreover, preferences for providers installing Open RAN would likely cause undue delay in the replacement of untrusted equipment, frustrating Congress's, and the Commission's, own policy objectives. The statute does not contemplate deadline waivers *solely* on the basis of a provider's choice of a particular network architecture, and the Commission should not write one into the statute.

Open RAN is progressing but, as evidenced by the comparative lack of uptake in the global market, still has a distance to go. Thus, while the rest of the world is committed to building out the 5G network platform, the U.S. should maintain its technologically neutral approach, allowing for the market to select the best solution based on price and performance. The Commission should encourage trialing, experimenting and industrializing Open RAN and continue to encourage the deployment of 5G to ensure continued U.S. technological leadership.

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COMMENTS OF ERICSSON

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Ericsson submits these comments in response to the Commission's Notice of Inquiry ("*Notice*"), which seeks to develop a record on the current state of Open Radio Access Networks ("Open RAN") and how to deploy Open RAN networks more broadly. As a trusted supplier to broadband networks in the U.S. and abroad,[1] and the world leader in the development, deployment, and operation of wireless network technology, Ericsson welcomes the opportunity to share its views on Open RAN.

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[1] Yesterday, the National Science Foundation launched the Resilient and Intelligent Next-Generation Systems ("RINGS") program. Along with public sector and private sector partners that include Apple, Google, IBM, Intel, Microsoft, Nokia, Qualcomm, and VMware, Ericsson will participate in the creation of a platform that will advance U.S. leadership in next-generation wireless networks and systems, strengthening U.S. competitiveness in a key technology area in the face of international supply-chain challenges. Announcement, *NSF-led, multi-sector partnership will support research that leads to superior communication networks and systems*, April 27, 2021, https://www.nsf.gov/news/special_reports/announcements/042721.jsp. In addition, Ericsson was recently awarded a project to demonstrate dynamic spectrum sharing at Hill Air Force Base, Utah. DOD Announces $600 Million for 5G Experimentation and Testing at Five Installations, Oct. 8, 2020, https://www.defense.gov/Newsroom/Releases/Release/Article/2376743/dod-announces-600-million-for-5g-experimentation-and-testing-at-five-installati/. Also, just in the past month the U.S. Ambassador to Greece congratulated the Greece operator COSMOTE for building "their 5G network exclusively with a trusted vendor, with Ericsson." Geoffrey R. Pyatt, U.S. Ambassador to Greece, Remarks at DigiTalks: 5G: Greece Changes Gears, Challenges and Opportunities (Mar. 3, 2021), https://gr.usembassy.gov/ambassador-pyatts-remarks-at-digitalks-5g-greece-changes-gears-challenges-and-opportunities.

I. INTRODUCTION

As a long-time supporter of open networks and a leader in the deployment of 5G offerings within the U.S. and across the globe, Ericsson applauds the Commission for opening this inquiry into Open RAN. Ericsson is an active participant in efforts to develop Open RAN standards, and has developed various cloud-based solutions, as well as other key elements critical to open 5G networks. The market is clearly trending toward openness. As it does, the Commission should refrain from conflating open networks generally with Open RAN in particular, and it should avoid using its power to place a governmental thumb on the scale in favor of any one particular network technology.

Rather than mandating particular network architectures, the policy of the Commission and the U.S. Government generally should continue to promote technology neutral and market-led approaches to innovation. The U.S. has clearly demonstrated that open and intense competition and market incentives, not government mandates, are the most effective way to mobilize the telecommunications industry to unlock innovation and create value. The U.S. led the world in 4G and the "app economy" not by insisting on any particular network standard, but by creating an open, predictable, and attractive investment climate for all industry stakeholders and allowing operators to select the best technology based on their needs.

Likewise, the U.S. Government should focus now on promoting the deployment of 5G itself – whichever technologies the marketplace deems as best suited to serve that need. In doing so, the Commission can and should promote 5G test beds that allow for experimentation with open interfaces and should continue to support U.S. participation in global standards-setting organizations. But it should not give preferences to network operators looking to deploy Open RAN, either in the context of "Rip and Replace" or elsewhere. American consumers will be best served by a framework that drives proliferation of 5G and lets the trend toward openness

continue organically. Ericsson looks forward to playing an integral part in these developments, as it has since it first entered the American marketplace in 1902.

II. ERICSSON IS THE GLOBAL LEADER IN 5G AND HAS A STRONG U.S. PRESENCE IN MANUFACTURING AND THE 5G ECOSYSTEM

Ericsson has consistently led the world in advancing the capabilities of wireless technology and devices, and continues to do so during the global migration to 5G. In order to capture the full potential of the 5G innovation platform, Ericsson's customers in the U.S. demand the most advanced solutions in the industry – and Ericsson is delivering. The company's solutions will enable the U.S. to leverage its lead in the Internet of Things ("IoT"), Artificial Intelligence ("AI"), and Multi-access Edge Computing ("MEC") to accelerate the digital transformation of a broad range of industries. These developments will have enormous economic impact: CTIA, for example, estimates that America's 5G economy will create roughly 4.5 million jobs and contribute $1.5 trillion in GDP from 2020 to 2030.[2]

A. Ericsson is at the Forefront of 5G Development and Deployment

Ericsson participated in many of the 5G "firsts," both in the U.S. and abroad. Notably, the very first 5G network in the world to go live with 5G was powered by Ericsson equipment.[3] The first 5G network to deliver peak speeds of 5.06 Gbps was deployed in the U.S. with cooperation

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[2] *See* Report, Boston Consulting Group, *5G Promises Massive Job and GDP Growth in the U.S.*, Feb. 2, 2021, https://www.ctia.org/news/report-5g-promises-massive-job-and-gdp-growth-in-the-u-s/.

[3] Although there is some debate over which country holds the "first to 5G" mantle (the difference in timing could have been by a few hours), Ericsson played a role in both launches. *See* Kenneth Li and Ju-min Park, *Who was first to launch 5G? Depends who you ask*, Reuters, Apr. 5, 2019, https://www.reuters.com/article/us-telecoms-5g-idUSKCN1RH1V1; Ericsson, *5G Live Networks: SK Telecom*, https://www.ericsson.com/en/cases/2019/sk-telecom-has-switched-on-5g (last visited Apr. 19, 2021); Press Release, Ericsson, *Verizon awards 5G contract to Ericsson* (Dec. 11, 2017), https://www.ericsson.com/en/press-releases/2017/12/verizon-awards-5g-contract-to-ericsson.

from Verizon, Ericsson, and Qualcomm.[4] The world's first stand-alone 5G network was launched in the U.S. using Ericsson equipment.[5] Ericsson helped power the world's first 5G data over millimeter wave bands using standards-based devices.[6] And we are very proud to have been the first company to deliver 5G base stations manufactured at scale in the U.S.[7]

Recently, Ericsson was named a "Leader in the 2021 Magic Quadrant for 5G Network Infrastructure for Communications Service Providers" by independent IT research and advisory company Gartner.[8] The Gartner "Magic Quadrant for 5G Network Infrastructure for Communications Service Providers" report recognizes Ericsson's Leader position in both completeness of vision and ability to execute.

Ericsson ranks highest in the 5G network infrastructure market on the latest Frost Radar™, leveraging its current leadership in 4G network infrastructure market.[9] Frost & Sullivan

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[4] Press Release, Ericsson, *Verizon, Ericsson and Qualcomm first in the world to achieve 5G peak speed of 5.06 Gbps* (Oct. 20, 2020), https://www.ericsson.com/en/press-releases/6/2020/verizon-ericsson-and-qualcomm-first-in-the-world-to-achieve-5g-peak-speed-of-5.06-gbps.

[5] *See* Press Release, T-Mobile, *T-Mobile Launches World's First Nationwide Standalone 5G Network* (Aug. 4, 2020), https://investor.t-mobile.com/news-and-events/t-mobile-us-press-releases/press-release-details/2020/T-Mobile-Launches-Worlds-First-Nationwide-Standalone-5G-Network/default.aspx.

[6] *See* Press Release, AT&T, *AT&T Makes World's First Standards-Based Mobile 5G Millimeter Wave Connection* (Sept. 10, 2018), https://about.att.com/story/2018/5g_cities_2018_2019.html.

[7] *See* Press Release, Ericsson, *Ericsson delivers first U.S. manufactured 5G base station to Verizon* (Jul. 29, 2020), https://www.ericsson.com/en/news/2020/7/ericsson-delivers-first-us-manufactured--commercial-5g-base-station-verizon.

[8] *See* Press Release, Ericsson, *Ericsson named a Leader in the 2021 Gartner Magic Quadrant for 5G Network Infrastructure for Communications Service Providers report* (Feb. 23, 2021), https://www.ericsson.com/en/press-releases/2021/2/ericsson-named-a-leader-in-the-2021-gartner-magic-quadrant-for-5g-network-infrastructure-for-communications-service-providers-report.

[9] *See* Press Release, Ericsson, *Ericsson positioned as the leader in Frost Radar™: Global 5G Network Infrastructure Market, 2020* (Apr. 7, 2021), https://www.ericsson.com/en/news/2021/4/ericsson-top-ranking-on-5g-frost-radar. The Frost

independently plotted the top 20 companies from a field of more than 100 global industry participants. These companies either lead the market overall, lead a market segment, or were thought leaders in certain segments.

B. Ericsson is Investing in the U.S., Manufacturing in the U.S., and Fueling U.S. Innovation

The *Notice* suggests that 5G innovation is lagging in the U.S., and that Open RAN has the potential to advance 5G leadership in the U.S.[10] In fact, American success in 5G can and should involve vendors from around the globe, so long as they are *trusted* vendors. There is no shortage of research, development, and production of innovative 5G technology here on U.S. soil. Indeed, vendors headquartered elsewhere—most notably Ericsson—have played a critical role in advancing U.S. 5G from here in the U.S.

Ericsson's commitment to the U.S. is real, tangible, and stretches back to 1902—some 119 years. Ericsson has successfully brought every generation of mobile technology to the U.S. and its domestic operators. It has over 7,700 employees in the U.S. with R&D centers in Austin, Texas, Santa Clara, California, and Boise, Idaho. In addition, we invested over $100 million in our state-of-the-art, Industry 4.0, 5G Smart Factory in Lewisville, Texas, which started shipping the first 5G radios in May 2020. Further, to address the shortage of 5G workers and speed up network buildout, Ericsson will continue to invest in its Centers of Excellence to recruit, train, and develop 5G field workers.

The impact of our investments and presence makes this even more significant as wireless industry jobs enable more indirect economic benefits and jobs than other industries such as

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Radar™ reveals the market position of companies in a particular industry using their Growth and Innovation scores as highlighted in the Frost Radar™ methodology.

[10] *See, e.g.*, *Promoting the Deployment of 5G Open Radio Access Networks*, Notice of Inquiry, GN Docket No. 21-63, FCC 21-31, at ¶ 23 (rel. Mar. 18, 2021) ("*Notice*").

restaurants and manufacturing.[11] This will continue through the 5G era with almost 5 new industry jobs created for every 1 wireless job,[12] which depend on Ericsson's technology as a core enabler for the rest of the wireless industry.

Although our global headquarters is in Stockholm, Sweden, the U.S. is Ericsson's *de facto* home market, and we are committed to enabling its 5G leadership ambitions. The U.S. represents over 30% of global business volume for Ericsson. The U.S. has a unique leadership position in 5G with early commercial 5G deployments, and Ericsson helped launch these commercial 5G networks. Ericsson was first to launch 5G with all Tier 1 operators, has five live 5G networks in the U.S., and globally powers 83 live 5G networks on five continents.[13] Recently, Ericsson hit a single-user 5G uplink speed record using multiple input multiple output ("MIMO") technology in the C-band.[14]

Ericsson's technology innovations result from significant, long-standing, and continuing investments made in the U.S., including:

- ***Investment in the U.S. 5G ecosystem.*** In an effort to expand the 5G ecosystem to startups and enterprises, Ericsson's D-15 facility in Silicon Valley operates advanced labs and resources, which push the boundaries in 5G use cases, including new critical focus areas such as AI, Industry 4.0, and IoT services.

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[11] *See* https://api.ctia.org/wp-content/uploads/2018/04/Accenture-Strategy-Wireless-Industry-Powers-US-Economy-2018-POV.pdf.

[12] *See* https://api.ctia.org/wp-content/uploads/2021/01/5G-Promises-Massive-Job-and-GDP-Growth-in-the-US_Feb-2021.pdf.

[13] Ericsson, *135 commercial 5G agreements or contracts with unique operators*, https://www.ericsson.com/en/5g/contracts (last visited Apr. 19, 2021).

[14] *See* "Ericsson pushes 5G uplink limits with MIMO," Fierce Wireless, https://www.fiercewireless.com/5g/ericsson-pushes-5g-uplink-limits-mimo.

- *Investment in domestic design.* Ericsson invests and supports technology development in the U.S., including hardware, software, and AI—areas in which the U.S. is at the forefront. In 2017, Ericsson established an application specific integrated circuit ("ASIC") and software design center in Austin, Texas. This center designs software and hardware for 5G radios which are now deployed in the U.S. and the rest of the world.

- *Investment in domestic manufacturing.* Ericsson recognized early that the scale of 5G meant that radio manufacturing would have to reside in the U.S. to maintain security and speed up 5G deployment. Ericsson has committed to 5G manufacturing with its Smart Factory in Lewisville, Texas, where it is showcasing the many opportunities arising from 5G connectivity, which powers capabilities including autonomous robots, augmented reality training, and many others. The Smart Factory recently received Leadership in Energy and Environmental Design ("LEED") Gold certification. LEED is a globally recognized symbol of sustainability achievement and a framework for developing healthy, efficient, and cost-saving green buildings. This recognition is one more step towards reaching Ericsson's target to make company operations carbon neutral by 2030.

- *Investment in domestic jobs and workers.* The deployment of 5G requires a large number of new small-cell sites, which creates unprecedented demand on a limited supply of 5G workers in the U.S. Ericsson has taken an active role in addressing this situation through its five state-of-the-art Center of Excellence facilities, which train and hire new qualified technicians and upskill current workers.

- *Investment in open network solutions.* Ericsson is a leading contributor to 3GPP standards, which define open interoperable interfaces between devices and the network. Ericsson also actively participates in the O-RAN Alliance,[15] chairing two working groups, and is the editor of several O-RAN specifications. Ericsson is also actively involved in the Security Focus Group, Architecture Working Group, and O-RAN Governance.

These facts and figures should make clear that the location of a company's headquarters does not alone determine its contributions to American competitiveness or success. In Ericsson's case, approximately 90% of the value of our active RAN components (*e.g.*, silicon, signal processors, etc.) are from U.S. companies.

Indeed, Ericsson's commitment to the U.S. economy often seems to eclipse that of companies complaining the loudest about the supposed lack of U.S. 5G leadership, some of which have only a handful of their employees in the U.S.[16]

III. **ERICSSON IS COMMITTED TO OPEN ARCHITECTURES, AND THE COMMISSION SHOULD LET THE MARKET AND TECHNOLOGY TRENDS DETERMINE NETWORK DESIGN**

A. **Ericsson is Committed to Developing Open and Interoperable Networks**

Consistent with its commitment to openness, Ericsson has introduced its Cloud RAN portfolio, the Open RAN solution from Ericsson focusing on hardware software disaggregation, cloudification, open automation, and orchestration. Ericsson sees demand from our customers to build 5G networks quickly and we are meeting that need with a mix of dedicated solutions and

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[15] *See infra* Part III, B.

[16] Mavenir plc, U.S. Securities and Exchange Commission Form S-1/A, at 39 (filed Oct. 26, 2020), https://sec.report/Document/0001193125-20-276115 ("As of September 30, 2020, 86% of our employees were located outside of the United States.").

products like Ericsson Cloud RAN that move more network functionality to commercial, off-the-shelf hardware. Our Cloud RAN solution represents a significant evolution that serves as a complementary addition to a service provider's purpose-built 5G network.

Cloud RAN consists of virtualized open DUs and virtualized open CUs as software applications. It allows hardware software disaggregation, cloud-native implementation using open software principles, and open interfaces for automation and orchestration. This approach advances the cause of "software-ization" of RAN workloads and flexible orchestration, adds flexibility for new deployment scenarios, and paves the way for increased agility with cloud-based automation and orchestration.[17]

Ericsson undertook its cloud RAN initiative when it did because the time was right from a *technology* and *business* perspective. Not long ago, it would have been unlikely to think about service providers bringing virtualization to their network deployments. But much has changed since in just a few short years – 5G came with force and with it came the demand for new levels of flexibility in architecting, scaling and deploying wireless broadband networks. The progression of technology has allowed for more open and software-centric products such as cloud RAN. As technology marches on, we expect further innovations in openness as well as other developments, including new air interfaces.

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[17] For example, cloud RAN will benefit public safety, as it enables distribution of RAN functions to secure cloud data centers while placing the RAN closer to 5G core network functions with MEC. Public safety services will become more resilient using 5G as the core network functions transition from a centralized deployment model at fewer sites to a distributed model with more sites closer to the RAN. Coupled with 3GPP network slicing technology, 5G Cloud RAN and MEC will provide resilient mission-critical services for public safety that are ensured dedicated resources and tailored security while sharing commercial infrastructure. These evolving advantages for public safety will be gained from technologies that are independent of the O-RAN architecture.

What works for Ericsson, though, may not work for our competitors. Our offerings are based on the needs of our customers, our research and expertise in radio technology, the economics of being a global supplier, and a host of other factors. Others working in our space will, and do, meet the needs of the market with their own mix of open and integrated solutions. The U.S. has the most innovative and competitive high-tech marketplace in the world and is proud to play role in that market. A major key to that success is the fact that the *market* determines which technologies win, and which lose. Governments tipping the scales in the technology arena generally do not generate desired outcomes, and it would be a gamble to push innovators on any particular technology path – especially in an area in which technical specifications are still being developed. For this reason, the Commission has never dictated a particular network architecture (and it is not clear that it even has the authority to do so). Ericsson thus asks that the Commission continue its approach to leveraging market forces and technical advances to drive network architecture, and not impose requirements or firm preferences designed to push the market toward Open RAN.[18]

Reading the exaggerated claims of some players, one would think that networks in the U.S. are closed today, but this is not so. When operators in the U.S. roll out or expand their wireless networks, they send RFPs to literally hundreds of potential vendors. The 5G procurement process in the U.S. includes over 400 vendors. In certain areas of the network, there may be fewer vendors. Given the economics and the technological complexity of RAN manufacturing, that market is, for the most part, split between Ericsson, Nokia, and Samsung.

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[18] It is also unclear how open RAN policies would even be defined as "Open RAN" is not a standard. There are organizations that are working on standards development such as O-RAN, but betting on a horse this early would be a large gamble and could bifurcate standards, possibly risking the real prize – the economic benefit of $1.5 trillion in GDP growth and 4.5 million jobs this decade in the U.S. economy.

The challenge of shipping millions of radios per year, coupled with the specialized nature of the research and development involved, limits the market to fewer, large players. Just as other industries have consolidated over the years (consider the commercial aircraft market dominated by Boeing and Airbus, or the chip foundry market, dominated by TSMC and Samsung[19]), so too is the RAN market. But this does not mean that the process is "closed" – Ericsson can attest to the fierce rivalry among RAN manufacturers, and the breakneck innovation in RAN technology attests to that competition.

Likewise, openness is an inherent virtue of 3GPP, which consists of more than 100 open interfaces already. The path to more open networks is not a new phenomenon. Since the dawn of the definition of GSM, 3GPP has incorporated hundreds of specifications and interfaces from over 700 members worldwide.[20] The quest for an open set of network standards supporting solutions from multiple vendors and service providers has produced significant economies of scale, pushing the marketplace toward greater openness. None of these advancements came about because governments required that Ericsson and other trusted suppliers employ a particular technology. They occurred because consumer demand, technological reality, and basic economics pushed the ecosystem in that direction.

Ericsson's commitment to openness is also evidenced by its support for the recent DoD announcement of a 5G Challenge to accelerate the development of an open 5G stack

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[19] Arjun Kharpal, *How Asia came to dominate chipmaking and what the U.S. wants to do about it*, CNBC, Apr. 11 2021, https://www.cnbc.com/2021/04/12/us-semiconductor-policy-looks-to-cut-out-china-secure-supply-chain.html.

[20] *See* Caroline Gabriel and Roberto Kompany, *Open RAN: ready for prime time?*, at 2, Analysys Mason (Apr. 2021), https://www.analysysmason.com/research/content/white-papers/open-ran-reality-rdns0-rma18.

ecosystem.[21] There, we suggested that the DoD set up a lab to which all vendors could bring their products for functional and interoperability testing. As these various initiatives show, Ericsson is not only committed to, but is well along the path of, developing 5G network technologies in which there are an ever-increasing number of open interfaces. This makes sense from a business perspective: Our customers around the globe are demanding that suppliers, including Ericsson, incorporate more openness. Ericsson believes, moreover, the push for more open networks will ultimately benefit the entire 5G ecosystem.

In sum, then, Ericsson heartily supports openness – as underscored by its Cloud RAN offerings – but urges the Commission to recognize the openness evident in the marketplace today, and to foreswear use of government mandates to drive the marketplace toward any particular vision of openness.

B.   Ericsson Recognizes the Merits of Open RAN Technology

Ericsson is a leader in the O-RAN Alliance, co-chairing two working groups and making more contributions to O-RAN specifications in 2020 than any other company, including innovations such as Non RT-RIC open platform and other open interfaces. Ericsson has the second-highest number of open source commitments ("OSC") and Open Network Automation Platform ("ONAP") unique authors, behind only AT&T in these areas. Ericsson is a leader in orchestration and multivendor management. Further, the company currently, or is planning to, support 8 of the 10 possible Open RAN interfaces being discussed in O-RAN architecture—four internal RAN interfaces inherited from 3GPP and four interfaces for RAN intelligence and automation.

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[21] *See* Comments of Ericsson, 5G Challenge Notice of Inquiry (filed Feb. 10, 2021).

IV. WHAT OPEN RAN IS AND OPPORTUNITIES FOR IT TO MATURE

Before considering policy responses to Open RAN, it is essential for the Commission to understand what Open RAN is, the role of 3GPP and the O-RAN Alliance in decisions regarding the wireless future, and the issues that must be addressed before Open RAN is ready for widespread commercial use.

A. What Open RAN Is

Open RAN is not a standard, but rather an industrial concept. It aims to disaggregate the RAN by creating more interfaces within it, thus parsing the RAN into smaller components and creating more open internal interfaces with the aim of adding new interfaces into one portion of wireless networks (the RAN) and helping to integrate new vendors into the supply chain.[22] Under an Open RAN framework, "[v]endors do not have to provide every element in a disaggregated architecture, so the supply chain can be extended to include more specialist providers alongside the end-to-end network vendors," but this approach "is only practicable if there are common interfaces between the elements."[23]

Openness itself is not new: "the whole history of cellular networks is bound up with the quest for an open set of network standards that would support solutions from multiple vendors and service providers and produce significant economies of scale."[24] The term "Open RAN" refers to three related developments: "cloudification" of wireless networks, introduction of increased of intelligence and automation, and the use of open internal RAN interfaces.
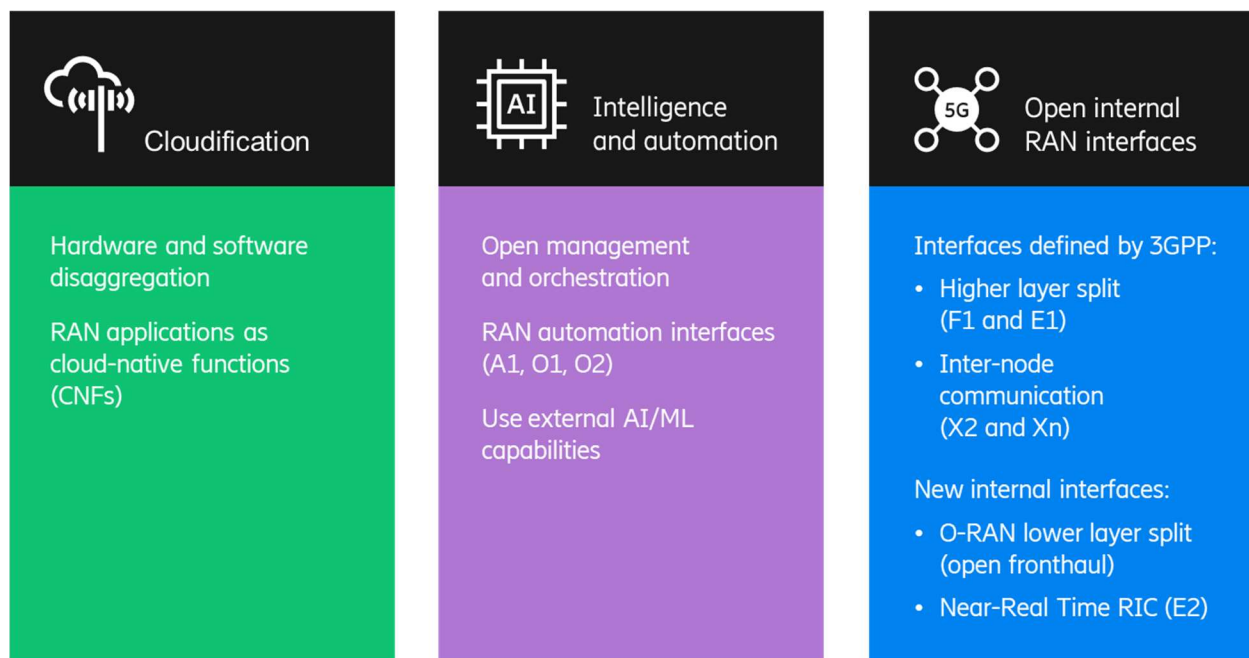
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[22] *See supra* note 20.

[23] *Id.*

[24] *Id.*

First, by "cloudification," Ericsson means the decoupling or disaggregating of software and hardware, allowing RAN software to run on vendor-independent hardware, increasing vendor diversity. An example is Ericsson's Cloud RAN portfolio, which allows Ericsson software to operate on third-party servers (*e.g.* Dell and HP), while running on processors from *other* vendors (*e.g.* Intel and AMD chips), and using cloud software from yet other providers (many of them U.S. companies).[25] Ericsson Cloud RAN will be deployed by U.S. operators.

Second, increased intelligence and automation, in turn, allows operators to use AI and machine learning ("ML") to automate and simplify network operations on these decoupled independent cloud platforms, allowing apps that control the radio network to be written by third parties, further supporting vendor diversity.

Third, open interfaces build on 3GPP interfaces by adding more capabilities. Some of these interfaces are available today, while others will take time to mature. The figure below helps describe what is meant by these terms and what RAN interfaces are included in each area.

Cloudification	Intelligence and automation	Open internal RAN interfaces
Hardware and software disaggregation RAN applications as cloud-native functions (CNFs)	Open management and orchestration RAN automation interfaces (A1, O1, O2) Use external AI/ML capabilities	Interfaces defined by 3GPP: • Higher layer split (F1 and E1) • Inter-node communication (X2 and Xn) New internal interfaces: • O-RAN lower layer split (open fronthaul) • Near-Real Time RIC (E2)

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[25] Ericsson's Cloud RAN solution is described in more detail below. *See supra* Part III, A.

B. The Role Played by 3GPP and the O-RAN Alliance

To understand what Open RAN is and is not, it is critical to understand the respective roles played by 3GPP and the O-RAN Alliance in the 5G ecosystem.

1. 3GPP

3GPP is a partnership of seven telecommunications standard development organizations ("SDO") from around the world that provides an open, transparent, and established setting to develop critical global standards for wireless communications. Together, these organizations form a robust contributions-based group representing over 700 companies.

3GPP has successfully developed open platform standards for each generation of wireless technology, from 3G to 5G, enabling 8 billion mobile subscriptions. 3GPP standards allow full interoperability among networks, devices, and applications. A 2019 RCRWireless article provides a concise summation of the importance of 3GPP to the mobile ecosystem: "3GPP is a truly democratic, consensus-based organization. Its structure and culture that encourages collaboration, even among bitter business rivals, has made it a premier standards development organization."[26] As a 2017 Forbes article noted, "3GPP is crucial to today's cellular standards" and has been the "most instrumental in establishing the truly global cross-industry interoperable wireless broadband standards" that billions of global citizens and countless businesses rely on every day.[27] In short, today's global broadband ecosystem owes its existence, in no small part, to 3GPP. And Ericsson is a leading contributor to 3GPP's standards-setting bodies.

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[26] Prakash Sangam, *The inside story of 3GPP–Who are the unsung heroes that create the standards? (Analyst Angle)*, RCR Wireless News, Aug. 19, 2019, https://www.rcrwireless.com/20190819/analyst-angle/inside-story-3gpp-analyst-angle.

[27] Patrick Moorhead, *The Crucial Role Of Wireless Industry Standards In 5G*, Forbes, Sept. 1, 2017, https://www.forbes.com/sites/patrickmoorhead/2017/09/01/the-crucial-role-of-wireless-industry-standards-in-5g/?sh=28cc305d2cff.

Vendor diversity is a hallmark of 3GPP. In the 5G ecosystem alone, there are over 400 players involved. The U.S. has the highest number of active vendor partnerships in commercial 5G networks across all of the network domains shown in the figure below. Major companies include Cisco, Affirmed/Microsoft, HP, Oracle, Dell/VMWare, Juniper, Ciena, Corning, Intel, Marvell, Qualcomm, Amazon, Microsoft, Google.
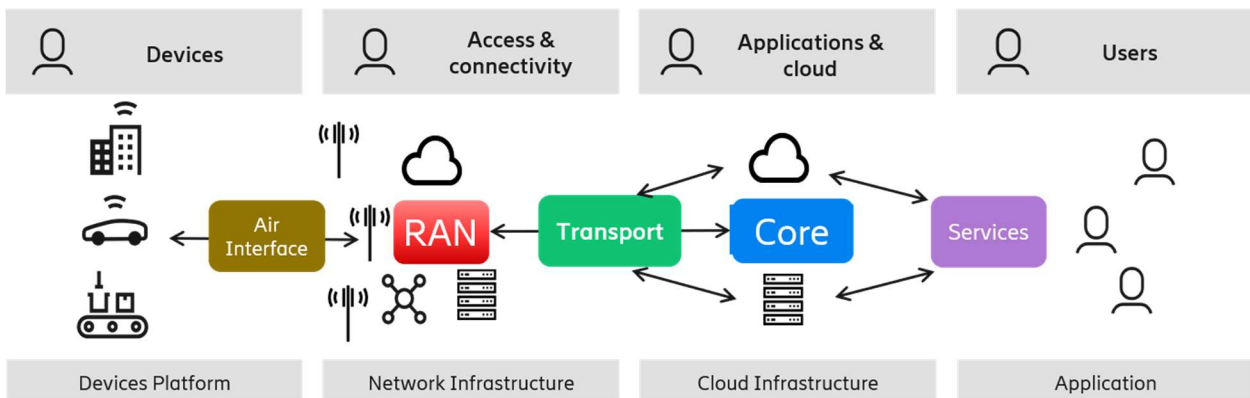
3GPP was developed to allow the creation of a cellular standards with worldwide interoperability and global economies of scale. To achieve this global scope, 3GPP was formed as a partnership of national and regional standards organizations, such as ATIS for the United States. For over twenty years, 3GPP has effectively managed the tension between meeting regional requirements and ensuring a global telecommunications system. It has done this through a policy of openness and promoting consensus-based technology and technical merit decisions. Since 3GPP is a partnership of accredited SDOs, the decision-making processes and rules governing 3GPP must satisfy the openness requirements of those standards organizations as prescribed by the World Trade Organization's Technical Barriers to Trade agreement.

Any company may join and develop its own set of products (integrated or disaggregated) based on these technical specifications. Current industry network development built on 3GPP specifications benefits from a standardized environment to deploy platforms, applications, and

services. 3GPP has been very effective in its over twenty-year history by establishing a

commonality in the wireless space that has allowed innovation to flourish.

2. The O-RAN Alliance

The O-RAN Alliance is a relatively new organization that took work from 3GPP's

standards organizations as its baseline and set out to create extensions specifically for the RAN.

Open RAN is built on top of 3GPP standards; Open RAN is not a competitor to 3GPP. It is

focusing on standardizing the open and interoperable interfaces between the three components of

the RAN: the Radio Unit ("RU"); the Central Unit ("CU"); and the Distributed Unit ("DU").

3GPP already defined an open and interoperable interface between the DU and the CU, which

the O-RAN Alliance has inherited. Much of the O-RAN Alliance's focus has been on defining an

interoperable interface between the DU and the RU. The O-RAN Alliance is defining

specifications for a version of Open RAN called O-RAN. The Commission must not conflate the

concept of Open RAN with O-RAN compliant specifications.

Just as the case with other global standards groups, the O-RAN Alliance is very diverse,

with companies represented from around the globe. The O-RAN Alliance was founded in 2018

by AT&T, China Mobile, and others, now comprises 28 operators and 224 vendor companies (as

of March 4, 2021).[28] U.S. members make up the largest proportion of participants, roughly one-

third, while China follows with about one-fifth of total members.[29] The goals of the organization

are to provide detailed blueprints for how to build a 4G and a 5G RAN solution enabling parts

from different vendors, including defining mechanisms for efficient management and control.

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[28] O-RAN Alliance, Membership, https://www.o-ran.org/membership (last visited Apr. 19, 2021).

[29] John Strand, *44 Chinese companies have joined the O-RAN Alliance*, IEEE Communications Society, Technology Blog, Dec. 17, 2020, https://techblog.comsoc.org/2020/12/17/44-chinese-companies-have-joined-the-o-ran-alliance.

Thus, there will be no Open RAN solutions for 2G and 3G networks based on O-RAN Alliance specifications.

3. Support for Strong Intellectual Property Rights

Support for strong intellectual property ("IP") rights, including patents, is critical in fostering the development of 5G and 6G technology. Strong support for IP rights also plays an important role in encouraging R&D investment that can help facilitate the creation and use of Open RAN technologies. Robust IP protection and an open, transparent, balanced, and voluntary consensus-based standards development process are essential to ensure the long-term security, interoperability, viability, and competitiveness of the telecommunications marketplace. IP encourages further investment in R&D for 5G, 6G and beyond by providing innovators with the ability to create value for consumers, recoup a fair share of that value, and reinvest in the creation of key technology. This recurring investment in the innovation ecosystem ensures the vibrancy of diverse business models by allowing for more players in the marketplace offering an array of the most inclusive and international applicable technology available, with a competitive, broader base of innovators and implementers, that ultimately benefits consumers. Strong IP protections and the openness of the standards development process also protect against technology theft and help ensure the trustworthiness and security of 5G networks.

An open, transparent, balanced, and voluntary consensus-based standards development process (such as the process used at 3GPP and its regional partners) creates a dynamic and competitive marketplace enabling the development of the best technology. FRAND licensing (licensing on Fair, Reasonable and, Non-Discriminatory terms) is a critical aspect of the continued innovation and competitiveness in 5G. A FRAND licensing framework ensures access to the standard by the ecosystem, lowers barriers to entry and encourages competition, creates wide choices for consumers, and improves product quality. Ericsson, as a leading supplier of

wireless network equipment, a leading contributor to standardized technologies, a leading member of SDOs, and both a licensor and licensee of patents that are essential to implementation of voluntary collaborative standards, holds 57,000 granted patents. The continued viability of investment in collaborative technology standards development, whether by Ericsson or others, however, depends upon the continuation of a balanced approach to FRAND licensing. On one hand, FRAND allows third parties – including competitors – access to the cutting-edge patented technology essential to the standards. This is especially important in industries that demand technical interoperability (like 5G) to achieve broad commercial success and increases the incentive for competitors to collaborate on technical development and contribute their best technology for the good of the whole market. Agencies of the U.S. Government, including the DOJ and the USPTO, recognize that this cooperation is pro-competitive and benefits consumers.[30] On the other hand, FRAND adequately and fairly rewards innovators for their contribution of cutting-edge patented technology into open standards, which in turn promotes continuous innovation. These goals work together to form a delicate balance between the interests of innovators and technology users and have served well in a period of rapid technological advances.

NIST, and other federal agencies, recently reinforced the continued importance of balance in the innovation ecosystem and affirmed the commitment by U.S. agencies to promote policy goals that encourage the long term viability and diversity of competitive business models

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[30] *See* May 28, 2020 DOJ Deputy Assistant Attorney General for Antitrust Alexander Okuliar Speech at https://www.justice.gov/opa/speech/file/1281926/download.

for the licensing market that ultimately benefits consumers.[31] The importance of this goal to support the FRAND balance through comprehensive and sensible governmental policies in this area also extends beyond U.S. borders. Other countries look to the U.S. for guidance on issues relating to global standards and FRAND licensing. We encourage the continued support for policies that reflect these important principles and provide a clear, balanced and unified message on the importance of respect for IP protections, U.S. private sector leadership in open, transparent, and voluntary consensus-based SDOs, and robust support for FRAND licensing commitments.

Open RAN technologies build off existing RAN technologies created by 3GPP, ATIS, ETSI and other SDOs. The carefully balanced innovation ecosystem for 5G, 6G, and beyond, within the 3GPP environment, continues to serve consumers, industry, and society at large. Industry's commitment to FRAND licensing in the 5G ecosystem is vital to ensure continued contribution of cutting-edge R&D, global interoperability, network security, and the best technology in the market, at reasonable prices, ultimately providing benefits to the end user, the consumer. In the absence of industry's commitment to FRAND, the ecosystem would gravitate to fragmented proprietary technology solutions with higher prices for consumers and a lack of predictability over access to technology.

Today's telecommunications standards bodies seek to create cutting-edge technology standards based on contributors' IP rights. Efforts to undermine or weaken IP threaten the standardization ecosystem by disincentivizing companies from contributing their technology. To encourage creation and adoption of standards, it is important for SDOs to attract technology

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[31] U.S. Patent & Trademark Office, Nat'l Institute of Standards & Tech., and U.S. Dep't of Justice, Policy Statement on Remedies for Standard-Essential Patents Subject to Voluntary F/RAND Commitments (2019) https://www.justice.gov/atr/page/file/1228016/download.

contributions and approve standards for which patent holders have committed to license essential patents on FRAND terms.

Recent reports have noted the critical role that strong IP protections play in maintaining U.S. global leadership in emerging technologies including 5G. The final report by the National Security Commission on Artificial Intelligence released in March 2021 noted the importance of intellectual property rights with respect to emerging technologies (such as 5G) and the need for the U.S. to maintain a leadership role in standard essential patents.[32] The report also noted the need for a more critical assessment of information often reported publicly about technological leadership in SDOs when that information relies on the number of patents declared as potentially essential to technologies such as 5G.[33] Strong intellectual property protections, including respect for patent rights, are key to maintaining U.S. technological leadership, security, and a competitive innovation ecosystem in 5G, 6G and beyond.

C.   Opportunities for Open RAN to Mature

Today there are 139 live 5G networks in the world and only one (Rakuten) is based on Open RAN with limited use of O-RAN Alliance open fronthaul interfaces. Despite claims of there being approximately 40 global networks partially based on Open RAN, fewer than 10 are O-RAN Alliance specification compliant. Open RAN, as it develops, has the potential to benefit the industry. Although a promising technology, Open RAN is very early in its life cycle.

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[32] Nat'l Sec. Comm'n on Artificial Intelligence, Final Report, Nat'l Sec. Comm'n on Artificial Intelligence 473, 465 (2021) ("America's intellectual property (IP) laws and institutions must be considered as critical components for safeguarding U.S. national security interests, including advancing economic prosperity and technology competitiveness.")

[33] *Id.* at 470.

Specifications will take time to evolve, which means that today there are several challenges related to successful adoption:

- **_Security._** The disaggregated and multivendor nature of Open RAN expands the threat and attack surface of the network in numerous ways, which will require additional security measures. Efforts to address the security risks have just begun within the O-RAN Alliance, and Ericsson is contributing to this work, which aims to evolve the security architecture to make it more robust.

  It is important to note that the O-RAN Alliance is a closed technology organization that requires membership to access its specifications, unlike open SDOs such as 3GPP. Non-members are permitted access to specifications only upon accepting a licensing agreement[34] in which the non-member party agrees to the terms of the Copyright and FRAND licenses, including a Binding on Affiliates, that may not be acceptable for CSRIC to sufficiently study O-RAN's security risks. The relationship between the O-RAN Alliance and FCC, and O-RAN Alliance and CSRIC members, must be given careful consideration prior to re-chartering the CSRIC to study and provide recommendations for O-RAN specific technology. We provide more detail on the security considerations for Open RAN deployments below.

- **_System Integration._** Integration of multi-vendor systems over multiple generations of hardware and software technologies is complicated. Mobile network operators will need to bring in a system integrator to stitch together all the disparate pieces to create an integrated solution before it can be deployed. This work will continue every time

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[34] https://www.o-ran.org/adopter-license.

any one vendor's component of the stack goes through a change, such as new feature addition. This will take time and add to the cost, complexity, and time-to-revenue for network operators. In most of the cases, the system integrator will not be able to fix issues in the network and the operator will need to rely on the willingness of the involved vendor to make changes in their products for the sake of interoperability.

- *Feature Parity/Performance.* The overall system's performance can only be as good as that of the lowest-performing vendor component in the overall system. Unlike current RAN solutions, accountability for Open RAN network performance will be spread across many vendors, which makes performance management an on-going challenge for the operators, adding to their overhead costs.

- *Intellectual Property Rights ("IPR").* Some RAN vendors, who are major IPR holders, are not part of the O-RAN Alliance. This creates risk in IPR protection for the individual companies implementing O-RAN architecture.

- *Standards Readiness.* O-RAN Alliance specifications are still a work in progress. Standards will need to be finalized before Open RAN can be widely deployed.

- *Lack of Legacy Support for Older Networks.* The O-RAN Alliance is looking only to building specifications for 4G and 5G networks. Thus, the vast number of networks still in use globally and in the U.S. that are 2G- and 3G-based will have no legacy support from O-RAN. This issue could further complicate Open RAN's proliferation.

While each of these considerations is important, network security warrants additional discussion. The *Notice* asks a number of important questions relating to the security of networks. It is important to stress the difference between network and cybersecurity, on the one hand, and diversity, on the other. Open RAN, to the extent that it creates opportunities for more vendors,

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can increase supplier diversity, which is certainly one aspect of security. However, Open RAN

itself is not designed to meet challenges related to cybersecurity.[35]

The Open RAN attack surface shown in the figure below includes 3GPP Releases 15 and

16 for 5G, upon which Open RAN is built, and highlights the new threats posed by Open RAN

architecture:
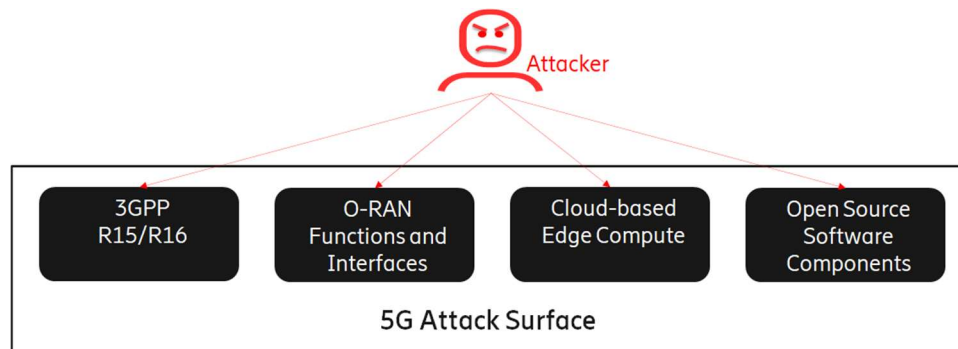
As this figure illustrates, Open RAN Architecture introduces new security risks for

attacks on confidentiality, integrity, and availability, including the following:

- An expanded attack surface with more functions and interfaces;

- Vulnerabilities in the Near Real-Time RAN Intelligent Controller ("Near-RT RIC")
  and xApps that could be exploited; and

- Non-secure management interfaces that do not follow industry best practices.

The challenges with securing Open RAN are specific to the O-RAN Alliance's

fragmented standardization process. Security was not properly addressed until the O-RAN

Alliance formed the Security Task Group ("STG") in March 2020 as a task group inside of WG1

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[35] The concepts discussed in this section concern architectures which propose to create an open fronthaul interface. Thus, the concerns are applicable to O-RAN and other similar Open RAN architectures.

– O-RAN Architecture. In February 2021, the O-RAN Alliance elevated the STG to a focus

group, now called the Security Focus Group ("SFG"), as an umbrella organization advising with

respect to security in standards produced by all O-RAN working groups. Operators in the

O-RAN Alliance support securing Open RAN to match the level of the security in their current

networks with the understanding that it may impact cost. The SFG is cognizant of all

vulnerabilities identified by Ericsson and has adopted work items to resolve each one. The

timeline for this work extends into 2022 because some vulnerabilities – particularly those related

to xApps – will be more complex to address.

The O-RAN architecture adds new functions (SMO, Near-RT RIC, and Non-RT-RIC)

and new interfaces (A1, E2, O1, O2, and Open Fronthaul, which is used for the architectural

modification called the Lower Layer Split ("LLS") 7-2x). The graphic below shows the O-RAN

Alliance's additional interfaces and function on top of a 3GPP RAN architecture.
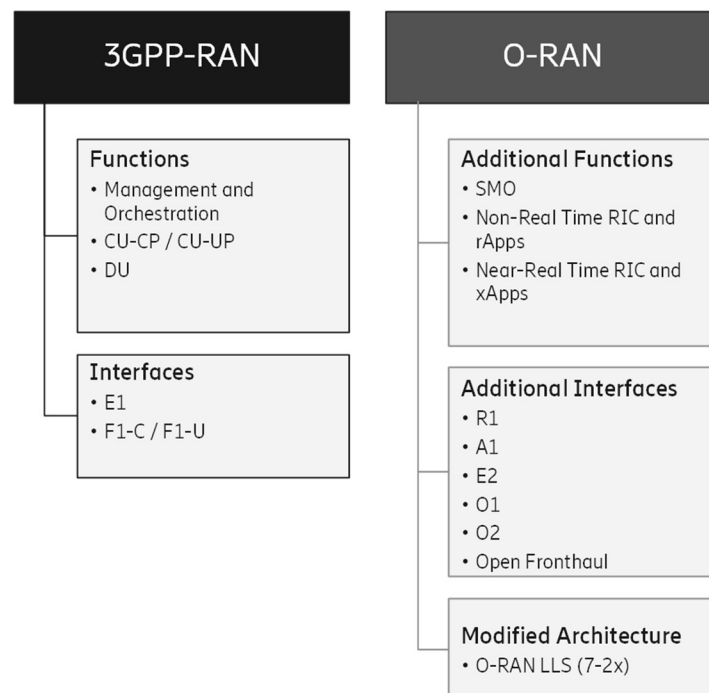
The O-RAN Open Fronthaul interface at the LLS includes the M-Plane for management

and the CUS-Plane for control, user traffic, and synchronization. Currently, the O-RAN Alliance

specifies the M-Plane to use SSHv2 with password-based authentication, which provides weak

protection from unauthorized access. The M-Plane should follow industry best practice using

certificate-based mutual authentication with TLS 1.3, X.509, and PKI. A man-in-the-middle

attacker on the C/U/S-Plane can exploit the C-Plane by modifying or injecting unauthenticated

control messages or the S-Plane using Precision Time Protocol ("PTP") messaging to take over

as the Master Clock to degrade service or cause an outage.

The Near-RT RIC can cause direct and indirect conflicts of parameters at the gNB that

result in degradation of service or denial of service for an attack on availability. This attack

vector is exacerbated with third-party xApps from multiple vendors setting the same parameters

at the gNodeB. Direct and indirect conflicts between xApps and between xApps and gNB can

also cause degraded service or denial of service. xApps also have access to sensitive device

information, such as device-id and device location, that is at risk of information theft or tracking.

It is possible for a malicious attacker to breach an xApp, or for an authorized user to gain

unauthorized access to an xApp, to track a device or exploit the sensitive information.

Open source software ("OSS") is a powerful tool that can be used by development

organizations to accelerate innovation while reducing the development timeline, product time-to-

market, and overall cost. OSS provides a platform for talented coders to openly collaborate and

build software. The transparency of code reviewed by many expert eyeballs can reduce software

complexity and the number of bugs. OSS works optimally when developers behave as "good

citizens." Use of open source software ("OSS") presents increased risks that require a higher

level of due diligence by organizations developing and using software containing OSS. OSS is

vulnerable to many attack vectors, including intentional backdoors installed by malicious

developers, propagation of vulnerabilities through reuse, exploitation of publicly disclosed

vulnerabilities, and human error. It only takes a single third-party component from an upstream developer to unintentionally or maliciously slip in a vulnerability that has a cascade effect, introducing vulnerabilities that propagate and persist throughout the ecosystem, potentially for years.

Ericsson, as a regular contributor to the various OSS initiatives and projects, has vast experience in secure software development using industry best practices to integrate OSS into our products and solutions. Organizations can undertake the requisite level of diligence by applying industry best practices for supply chain security, secure software development, and secure software maintenance when using proprietary software and OSS in development projects. When security is properly addressed, OSS can be an important contributor to the development of virtual, cloud-native 5G RAN, including Open RAN and Core functions. This is particularly relevant for the O-RAN Software Community, which accepts contributions from all its member companies – among them, 44 Chinese companies, including China Mobile and ZTE. As the IEEE Communications Society has observed, these circumstances give rise to national security risk, and "leave open RAN in an awkward situation."[36] Currently, the O-RAN Alliance relies upon only CII Badging for self-attestation by the vendor. The SFG has a future work item on its agenda to provide guidelines for secure use of open source in O-RAN projects.

Other aspects of Open RAN architecture introduce risks, which are not exclusive to O-RAN. Network security is built upon a "trust stack" consisting of trusted hardware, trusted software, trusted deployment, trusted applications, and trusted operations. Cloud deployments offer attackers an expanded threat surface due to the decoupling of the software from the hardware, multiple organizations sharing the same hardware, a third-party organization

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[36] *See supra* note 29.

managing the cloud infrastructure, and the use of open source software components. Containerized cloud-native applications are at risk from various threats, including (1) rogue processes that bypass isolation to access other containers sharing the same resources, (2) containers being deployed with known or unknown vulnerabilities, and (3) container or management platform misconfiguration. In a cloud environment, an external attacker could gain access to a compromised management platform or application and from there gain access to services, infrastructure, and remote devices. The chain of trust between these disparate components is not standardized and is implementation-dependent, making it challenging to determine the level of risk under the NIST Risk Management Framework ("RMF"). The NIST DevSecOps project is addressing best security practices for development of cloud-native applications and 3GPP is in the process of developing cloud security standards. Currently, there is no O-RAN SFG work item to secure Open RAN cloud deployments ("O-Cloud"), as other international standards bodies such as 3GPP are being relied upon.

Finally, Open RAN presents cost-related issues that must be addressed. O-RAN has defined a specific fronthaul lower layer split called 7-2x. This split suffers from poor performance characteristics especially for the advanced antenna systems that will form the bulk of 5G deployments and directionally key for the upcoming mid-band radio rollouts. The low performance of O-RAN radios will result in higher total cost of ownership ("TCO") as explained below.

Lower spectral efficiency with advanced antenna systems ("AAS," 16T-64T): O-RAN split 7-2x results in lower spectral efficiency for AAS radios. In contrast, Ericsson employs a more advanced split for AAS radios that increases the application coverage by up to 10 dB. This

translates into more efficient use of the radio spectrum resources and results in fewer sites to cover a given area compared to a deployment with only O-RAN radios.

Spectrum Sharing: Advanced radio features that place special requirements on the fronthaul interface are challenging to support with O-RAN 7-2x standards. As an example, advanced features such as Dynamic Spectrum Sharing, and Instantaneous spectrum sharing are difficult to realize with the O-RAN standard profiles. This leads to sub-optimal performance in O-RAN deployments and as a result, higher TCO to provide high performance coverage and user experience.

System Integration: Integration of multi-vendor systems over multiple generations of hardware and software technologies is complicated. Mobile network operators will need to bring in a system integrator to stitch together all the disparate pieces to create an integrated solution before it can be deployed, and the work will continue every time any one vendor piece goes through a change such as new feature addition. This will take time and add to the cost, complexity and time-to-revenue for the operators.

Also, sustainability is an area where current networks have focused to lower power costs and increase efficiency. In 2019, data transmission networks consumed 250 TWh, around 1% of global electricity consumption.[37] Energy efficiency in mobile networks has improved by 10-30% per annum in recent years and a continuous focus on breaking the energy curve should be a priority for the industry as 5G deployments continue. Ericsson estimates that, when considering the full network, Open RAN requires approximately 40% more energy than integrated networks.

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[37] *See*, Tracking Report, *Data Centres and Data Transmission Networks*, June 2020, https://www.iea.org/reports/data-centres-and-data-transmission-networks.

V.   NEXT STEPS FOR THE FCC AND OPEN RAN

While the Commission should not impose technological mandates or otherwise push the marketplace toward any particular architecture, there are several steps it can and should take to advance the public interest more broadly. We address these in turn below.

A.   The FCC Should Remain Stalwart in Pushing 5G

First, the Commission should keep its "eyes on the prize" by focusing on 5G deployment generally rather than Open RAN in particular. The benefits of 5G are beyond dispute. CTIA states that 5G will generate $1.5 trillion in GDP growth and 4.5 million jobs this decade in the U.S. economy alone.[38] 5G has the potential to transform the mobile connected world and revolutionize industries in ways that are comparable with the industrial revolution era. Globally, 5G is estimated to enable $13.2 trillion worth of economic output by 2035.[39] The World Economic Forum reports that, according to one study, the "5G global value chain" will generate some 22.3 million jobs by 2035.[40]

U.S. 5G success requires rapid buildout of the 5G infrastructure to establish the platform for innovation. Much of U.S. innovation and economic success is underpinned by this infrastructure. Just as 4G created huge opportunities for U.S. companies including Google, Facebook, and Uber, so too 5G will propel new ideas and new companies to success. Rapid deployment of networks also is critical to solving the digital divide and the "homework gap,"

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[38] *See* Boston Consulting Group, *5G Promises Massive Job and GDP Growth in the US* (Feb. 2021), https://api.ctia.org/wp-content/uploads/2021/01/5G-Promises-Massive-Job-and-GDP-Growth-in-the-US_Feb-2021.pdf.

[39] World Economic Forum and PwC, *The Impact of 5G: Creating New Value across Industries and Society* (Jan. 2020), https://www.pwc.com/gx/en/about-pwc/contribution-to-debate/wef-the-impact-of-fiveg-report.pdf.

[40] *Id*. at 5, 6.

whereas additional delays will put these unserved communities even further behind. Industry will continue to drive the new standards and technologies that form the foundation for success in these areas, but we must not be diverted by technology debates, and cannot wait for new standards to mature. It is critical to continue focusing on ways to accelerate current 5G deployments today to maximize gains and the economic benefits.

B.   The FCC Should Maintain Technological Neutrality

The policy of the Commission is, and should remain, technology neutral.[41] As noted above, government should not be in the business of mandating network architectures. History has demonstrated the best way to maximize the benefits of new technologies is to promote a competitive marketplace and let market forces work. It is important that the U.S. government support a technology neutral environment that promotes innovation, allowing the private sector to lead and the market to determine the "winners." The best price/performance ratio should carry the day.

History attests to the wisdom of market-led technological advance. U.S. leadership in technology in 4G and 5G has been achieved via technologically neutral policies, without any government mandates that tipped the scales. The market determined which standards would carry the day at key crossroads in previous wireless generations to reach the global scale and success of 4G LTE, but not without lessons learned from bifurcation of standards in the 2G/3G era (CDMA vs. GSM) along with challenges faced by TDD-only WiMAX and proprietary standards such as iDEN.

Indeed, when government has attempted to mandate particular technological approaches, these attempts generally backfired. A notable example was China's attempt to impose a national

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[41] *See Notice* at ¶ 71.

standard of TD-SCDMA during the 2G/3G generations to limit participation of foreign industry players. Under intense lobbying from a group of scientists, the Chinese government pooled national resources to support and roll out the indigenous TD-SCDMA 3G network in a bid to set the world standard. The Chinese government forced China Mobile, the biggest mobile phone operator, to adopt the home-grown technology. The result was disastrous: Speeds and reliability were not in line with other global standards, and customers had a limited range of products from which to choose that were compatible with TD-SCDMA networks. Not unsurprisingly, the TD-SCDMA standard failed to gain traction elsewhere in the world. After five years and spending more than 200 billion yuan (US$30 billion) in the TD-SCDMA 3G network buildout, developing compatible devices and marketing, China Mobile in 2014 began to phase out the technology as it migrated to the 4G network. The Chinese government also moved away from its top-down approach to adopt global LTE standards in time for 4G. Part of 4G LTE's success was the open standards foundation that 3GPP established with decisions based on consensus and open participation throughout each step of the standard-setting process. This costly lesson is still relevant today. In fact, the United States Trade Representative often cites this incident as one of the worst trade barriers imposed in the past 17 years worldwide.[42]

The Commission should reject the course that China adopted in the 2G/3G era, and instead, should let the marketplace determine which architectures the mobile ecosystem adopts.

C. The FCC Should Promote Test Beds

There are steps the Commission, in conjunction with other U.S. government entities, can take to encourage the development of more open network architectures generally. As the *Notice*

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[42] *See generally* U.S. Trade Representative, *2019 Report to Congress On China's WTO Compliance* (Mar. 2020), https://ustr.gov/sites/default/files/2019_Report_on_China%E2%80%99s_WTO_Compliance.pdf.

suggests, test beds can help move the ball forward.[43] For its part, last month Ericsson launched

the Ericsson Open Lab, a new space to collaborate and innovate with leading Ericsson Cloud

RAN customers and ecosystem partners to drive the development of virtualized 5G RAN

technologies.[44] The lab enables further development of Ericsson Cloud RAN solutions on

commercial off-the-shelf hardware, bringing higher efficiency and flexibility to 5G networks.

Ericsson's Open Lab also aims to help service providers pursue and realize new deployment and

5G use case scenarios, as well as create opportunities to increase automation and reduce manual

intervention. The lab offers space to further explore Open RAN technologies, including aspects

such as virtualization, management, and orchestration.

       The FCC and government partners should promote the development and use of similar

test beds. For example, the Commission could lend its expertise – on technology and policy alike

– to aid the Department of Defense's goal of defining a 5G open stack "challenge." We suggest

that the DoD manage a lab in which all vendors can bring their components of the open 5G stack

for functional and interoperability testing as well as perform ecosystem application testing. A

multi-vendor "Open Ecosystem Plugfest" will encourage vendors – both new and incumbents –

to contribute open 5G stack components within their areas of expertise and innovation. The

results of this testing will also help define a current state-of-the-art open ecosystem. An Open

Ecosystem Plugfest of this magnitude and importance will typically motivate the vendors to take

their products to the next level. It will also provide an opportunity for other market players to

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[43] *See Notice* at ¶ 63.

[44] Press Release, Ericsson, *New Ericsson Open Lab to drive network virtualization technologies*, Mar. 31, 2021, https://www.ericsson.com/en/press-releases/2021/3/new-ericsson-open-lab-to-drive-network-virtualization-technologies.

understand the developments and progress that have taken place toward an open ecosystem, thereby fostering further innovations in the overall open 5G stack market.[45]

D. The FCC Should Support U.S. Participation in Standards Groups

The Government should support industry engagement in global Standards Development Organizations (e.g., 3GPP, Institute of Electrical and Electronics Engineers, Internet Engineering Task Force) to assure industry-led forums remain the principle organizations for standards development. Separately, the Government needs to be engaged in nation-state forums such as the International Telecommunications Union to protect national interests.[46]

E. The FCC Should Not Delay Rip and Replace

Ericsson is staunchly opposed to any suggestion that an operator replacing untrusted equipment under the "Rip and Replace" process should receive special treatment *solely* based on the choice of a particular trusted solution. Congress used very explicit language when it required the Replacement List to be technology neutral.[47] The point of the Secure and Trusted Communications Networks Act was to prohibit "Federal subsidies from being used to purchase communications equipment or services posing national security risks [and] to provide for the establishment of a reimbursement program for the replacement of communications equipment or services posing such risks" – not to put a thumb on the scale of any particular network architecture.

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[45] See Ericsson Response, *5G Challenge Notice of Inquiry*, Feb. 10, 2021, https://www.ntia.doc.gov/files/ntia/publications/ericsson_02102021.pdf, at 3

[46] *See* DRAFT NSTAC REPORT TO THE PRESIDENT on Communications Resiliency, 2021, https://www.cisa.gov/sites/default/files/publications/Draft%20NSTAC%20Report%20to%20the%20President%20on%20CR%20%284-22-21%29_0.pdf.

[47] *See* 47 U.S.C. § 1603(d)(1)(b).

Among other problems, efforts to privilege providers installing Open RAN would likely cause undue delay in the replacement of untrusted equipment, frustrating the policy objectives behind "Rip and Replace." Security was on the mind of Congress, and the Commission, when they decided to require the removal of untrusted products from U.S. communications networks. Congress's preference for quick replacement of problematic network components is reflected in the Secure and Trusted Communications Networks Act ("STCNA"). The *Notice*'s suggestion[48] that the Commission could grant a delay solely on the basis of a technology choice is anathema to the letter and intent of that Act. The statute sets forth two mechanisms for waivers of deadlines for removal and replacement of covered equipment: (1) a blanket extension based on the Commission's determination that the supply of equipment is inadequate to meet demand (to date, there is no such indication that there is any particular shortage that would support this finding); and (2) individual exceptions for circumstances that, due to no fault of the recipient, lead to the recipient being "unable to complete the permanent removal, replacement, and disposal" of untrusted equipment.[49] There is no suggestion that a particular technology choice should be grounds, on its own, for waiving the timeframes contained in the Act. The Commission may not "grant an extension for providers seeking to deploy Open RAN or virtualized network equipment and services." Ericsson is a vendor of virtualized network equipment, but we recognize a choice from a provider – even one using Ericsson equipment – is not, standing on its own, a justification for an extension of time under STCNA. Nor is the choice of Open RAN equipment justification, on its own, for the grant of an extension.

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[48] *See Notice* at ¶ 68.

[49] 47 U.S.C. § 1603(d)(6).

Rather that conferring benefits on providers based on their technology choices, the Commission will (as with all waiver requests) need to determine whether the particular circumstances under which a provider seeks a waiver of the agency's deadlines justify such waiver. In this case, Congress has set forth the waiver standard, which is that the individual recipient must be "unable to complete" removal and replacement of equipment. A technology choice, on its own, does not meet the required showing that the recipient is "unable to complete" the task.

VI.   CONCLUSION

Ericsson has been, and remains, a leader in the development of mobile wireless technology and a uniquely successful contributor to America's 5G success. Ericsson is also a strong supporter of network openness, as evidenced by its own activities and products. Open RAN is progressing, but as evidenced by the comparative lack of uptake in the global market, still has a distance to go.

For the reasons described herein, however, the Commission should focus first and foremost on promoting 5G deployment, *not* on promoting particular types of 5G networks. The best way for the Commission to ensure open networks is not to put its thumb on the scale, but to advance 5G's proliferation, remain technology neutral, support test beds and American

participation in crucial standard-setting bodies, and refuse to give special treatment to companies solely on the basis of choosing to deploy Open RAN in the Rip and Replace context.

Respectfully submitted,

ERICSSON

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